Workshop Proposal: A Logic-System Simulator Designed for Teaching

Jean-Philippe Pellet[0000−0001−7559−397X]

University of Teacher Education, Lausanne, Switzerland
jean-philippe.pellet@hepl.ch

1 Motivation, Background, Relevance

We seem to have come out of the period when computer science was taught in school only from the perspective of software usage. Even if there is still a lot of work to be done on the adaptation of school programs and on the training of teachers, computer science is now seen as a separate science, much richer than its office applications.

A part of computer science that is still often missing in most of the courses we know deals with the basic architecture of computers, or more precisely with logic systems and basic components like an arithmetic logic unit (ALU) or a flip-flop. We think that there are some very interesting pedagogical moments to be experienced within this theme as early as high school. In particular, the realization of small circuits showing how to "calculate with electricity" or how to "store data with electricity", so to speak, seems adequate with appropriate teaching tools.

We believe that inspecting such "problem situations" is a way for learners to build a better notional machine of how a computer works, to concretely experiment with small systems "input-processing-output", and to realize how a gradual hardware abstraction allows us to eventually build a complete mini-system. We propose to do it without much formalism and instead try to build on (or develop some) "engineering intuition" of our students.

In the context of the development of new teaching resources for a mandatory CS-for-all course in high school, we have developed a free, open-source logic-system simulator that can be used in many more ways than a traditional simulator and which pedagocically makes sense, based on the PRIMM approach (*Predict-Run-Investigate-Modify-Make*). This workshop is dedicated to this tool.

2 Workshop Objectives

At the end of the workshop, the participants will be able to:

- Argue why logic systems can be a nice topic for teaching, even in a CS-for-all courses
- Use the logic-system simulator to design small circuits
- List the components the simulator can use and know what they do

– Understand and change the simulator's settings
– Create various pedagogical activities with the simulator for each of the PRIMM phases (*Predict-Run-Investigate-Modify-Make*)
– Embed the simulator in other LMSs or in a personal webpage

3 Activities and Format

Here is a rough plan for the 90-minute workshop:

Duration	**Content**
5 min	Introduction and context
10 min	Why teach logic circuits at all?
15 min	Interactive demo of the interface
15 min	Activity 1: full adder
15 min	Activity 2: ALU and flip-flops
15 min	Activity 3: design of one's own exercise
15 min	Concluding discussion and Q&A session

4 Used Materials

Participants should either come to the workshop with their own laptop or tablet or have access to a computer. Smartphones will not work well due to screen sizes. An internet connection is required as well as a modern browser. A projector in the room is needed for the presentation.

5 Abstract for Proceedings

Benefits of teaching of computer science is the teachers can get students can build small computer systems that can be interacted with. Examples include programming a graphical interface, a small robot, or an electronic board system like a Microbit or Arduino. In this workshop, we want to go down one step in the hardware layers while staying in the same state of mind: we demonstrate a tool for simulating logic gates and other basic computer components.

We show during the workshop how this simulator differs from other solutions by its pedagogical possibilities well suited to a PRIMM approach (*Predict-Run-Investigate-Modify-Make*), an extension of the well known *Use-Modify-Create* model. We highlight how the proposed tool makes it easy not only to design and simulate circuits (which all such simulators do), but also to distribute and share circuits, to tune simulation parameters, to hide parts of the circuits, to create investigation tasks, to include faulty components, and so on. All these features considerably enrich the pedagocial possibilities of the simulator and make it more useful for teachers.

In the workshop, we propose some pedagogical scenarios adapted to early high school students and show how teachers can create their own.

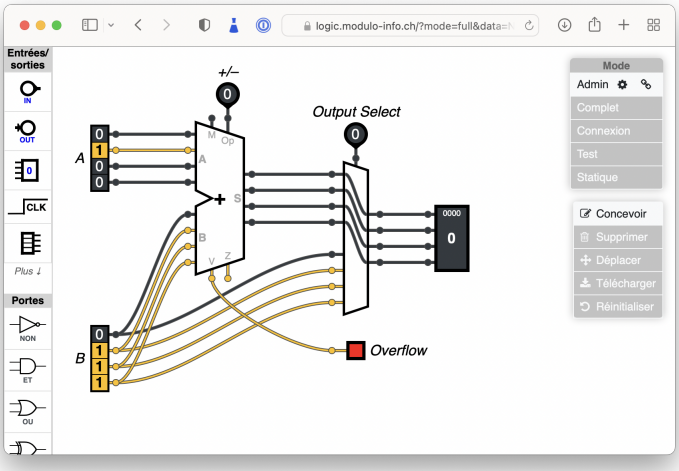

Fig. 1. Sample circuit (the interface will be in English for the workshop).

6 Organizer

Jean-Philippe Pellet obtained his Ph.D. in machine learning at ETH Zurich, Switzerland, in 2010. He currently is an assistant professor at the University of Teacher Education in Lausanne, Switzerland. He teaches basic computer science to pre-service primary teachers, and introductory programming and data science to future engineers at Ecole polytechnique fédérale de Lausanne. He is the main developer of the logic-system simulator presented in this workshop, which was developed in the context of new teaching material for mandatory CS courses at high school.